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EFFECTS OF SEEDBED TREATMENT ON GRASS ESTABLISHMENT ON LOGGING ROADBEDS IN CENTRAL IDAHO

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by

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INTRODUCTION

Soils derived from the granite of the Idaho Batholith of central Idaho erode rapidly when disturbed or bared by man's activities. Thus, logging roads needed to develop the timber resource necessarily expose a large area of unstable soil to damage by erosion. As a remedial practice, the bared areas are sown with perennial grasses that develop deep, fibrous root systems capable of binding and holding the soil, and that also provide litter cover and protect the soil from raindrop splash.

The seeding is usually done when logging roads are "put-to-bed" following timber harvest operations. Either motorized or hand seeders are used to broadcast seed. Usually no attempt is made to cover the seed or to precondition the hard-packed roadbed before seeding. The accepted practice in this area is to broadcast a mixture of seeds late in the fall. In the ponderosa pine areas east of the Cascades in Oregon and Washington, fall seeding is also the practice, according to Gjertson (4). The seeds lie dormant over winter and germinate as soon as snow disappears in the late winter or early spring. Experience has shown that spring seeding generally results in failure because the poorly developed seedling root systems cannot survive the hot, dry summers.

Field results from broadcasting seed have varied because of the diverse site conditions associated with roadbeds. Poor stands of perennial grasses have been as common as good stands. Consequently a more reliable method of establishing a dense grass cover on roadbeds is needed.

This paper presents the findings of a reseeding study designed to determine (a) whether scarifying a hard-packed roadbed, either before or after broadcasting seed, leads to establishment of a better stand of grass than one grown on an untreated roadbed, and (b) whether a wood-chip mulch, with or without fertilizer, further encourages the growth of grass. A secondary objective was an evaluation of the survival of five well-known perennial grass species growing on an extremely harsh site--the bare surface of a logging road.

DESCRIPTION OF THE STUDY AREA

The experimental area is 20 miles northeast of Idaho City on the Little Owl Creek drainage of the Boise National Forest. The elevation ranges from 5,000 to 6,000 feet and land slopes are moderately steep, averaging 46 percent (5). At this altitude ponderosa pine and Douglas-fir grow in mixed stands. The soil, a coarse-textured loamy sand typical of the Idaho Batholith, has a weak profile development, low humus content, and low water-holding capacity, and is highly erodible.

In the 3 years of study, annual precipitation as measured in gages within the study area, averaged 37 inches; of this amount 10.0 inches was received in the period April 1 through September 30, which includes the growing season. Within the period, April and May rains accounted for 7.8 inches; the remaining 2.2 inches fell during the 4-month dry period, June 1 through September 30. Compared with long-term U.S. Weather Bureau records for the closest stations, growing-season rainfall on the Little Owl area was slightly above normal for the three growing seasons following seeding.

ESTABLISHMENT OF THE STUDY

Two logging roads, each 1 mile in length, were selected for the study. One road was on generally south-facing slopes; the other on generally north-facing slopes. Hauling over the roads had ceased by October 1955, and earthen cross drains had been constructed at prescribed intervals ranging from 50 to 100 feet; the interval between these cross drains was designated a study plot. There were 64 plots per road, a total of 128.

The scarification treatments were

a. No roadbed preparation before or after broadcast seeding--(control).

b. Scarifying to a depth of 3 inches with a spike-tooth harrow, after seeding.

c. Scarifying to a depth of 12 inches with a six-tooth ripper mounted under a road patrol, after seeding.

d. Deep scarifying (12 inches) as in (c) above, followed by seeding.

These treatments were applied on the ground in groups of four contiguous plots of each treatment to minimize vehicular travel back and forth on roads.[1] Despite these precautions, unavoidable compaction occurred on many plots during the 3-week establishment period in October-November 1955. The scarification treatments (by blocks of four plots) were randomized and were replicated eight times.

The grass seed mixture included five perennials and a cereal grain (winter rye, *Secale cereale*) to provide temporary litter cover during the critical early years of perennial grass establishment. The perennials were two long-lived sod formers, Manchar smooth bromegrass (*Bromus inermis*) and intermediate wheatgrass (*Agropyron intermedium*); and three bunch formers, crested wheatgrass (*A. desertorum*), timothy (*Phleum pratense*), and bulbous bluegrass (*Poa bulbosa*). Although a shallow-rooted grass, bulbous bluegrass had adapted well to dry sites in the Boise National Forest. The rate of seeding for all species combined was 36 pounds per acre, as listed below:

Species	Rate/acre (lbs.)
Winter rye	20
Bulbous bluegrass	2
Standard crested wheatgrass	3
Intermediate wheatgrass	5
Manchar smooth bromegrass	5
Timothy	1

Superimposed upon the scarification treatments after seeding were three additional treatments: (a) fertilizer (equivalent to 40 pounds of nitrogen plus 40 pounds of phosphorus per acre) broadcast with hand spreaders; (b) wood chips (a layer about 1 inch thick) produced by feeding green slash into a tractor-mounted chipper, and spread over the plot manually with pitchforks; (c) fertilizer and wood chips in combination. On the fourth plot, only the scarification treatment was applied. The additional treatments were applied randomly to each group of plots.

[1] The authors acknowledge the excellent cooperation from the Ranger's staff and slash disposal crew of the Lowman District, Boise National Forest.

DATA COLLECTION

Field data were collected July 1-17, 1957, midway in the second growing season. At that time four of the treatment replications--64 plots--were sampled (two replications on each aspect road). One year later, July 1-17, 1958, all of the 128 plots were sampled, although 2 weeks before this sampling began, 21 plots on the south aspect road had been grazed by a band of sheep in trespass.

The density of grass seedlings (live plants per square foot) and the percent of ground cover were used to judge effectiveness of treatment. Sampling in each plot was done on four permanent 72-inch transects staked randomly crosswise to the axis of the roadbed--two in the inboard half and two in the outboard half. A previous survey found that the roadbeds averaged 16.5 feet in width (5). The notched side of a 4- by 72-inch sampling frame was anchored to the transect. Live plants within the frame were identified by species and counted, after which the notched side of the frame was used as a point sampler by insertion of a needlepoint gage at each notch successively. Percent ground cover was estimated from the number of basal hits on live vegetation and plant litter.

When plots were selected for treatment, none was eliminated to reduce experimental error caused by variations in soil, topography, aspect, and roadbed compaction. It was deemed impractical to do this with roads built on irregular terrain. Accordingly, site properties not common to every plot and hence not measured contributed to experimental error. However, site properties common to every plot were indexed empirically if they were thought to be related to seedling emergence and establishment, independent of treatment effects. For example, the percentage of each roadbed plot shaded at noon by surrounding trees and topography was estimated, and later used in an analysis of covariance.

ANALYSES

The data on individual species, on treatment effects, and on certain site properties were examined statistically by analyses of variance and covariance (8).

Some sources of variation that either could not be measured or were not deserve some discussion:

1. Some seed broadcast in the fall were lost through extraneous causes before germination in late winter. Had losses been uniform from plot to plot, the experimental consequences would not have been as serious. However, during the seeding operation small mammals were observed gathering and storing seed taken from some road surfaces but not from others. Obviously, such feeding would leave a nonuniform distribution of seed in the roadbed plots. Therefore, the sparseness of plants in some transects may very well be related to an initial lack of seed and not to differences in treatment and site.

Furthermore, in the time between seeding and germination, two major periods of overland flow occurred when seed may have been washed away completely or redistributed within the plot. The first such period was during the heavy rainstorms of December 19-24, 1955. The second was the normal snowmelt runoff in late March 1956.

2. Such soil properties as compaction, texture, and fertility, had they been defined directly rather than indexed empirically, might have explained more site variation between plots. An intensive study of soil properties should be given consideration in any new reseeding trials.

3. It is problematical whether within-plot variation would have been better defined by more intensive sampling. The decision to use four transects per plot was made primarily to provide a suitable workload for sampling a large number of replications.

RESULTS OF TREATMENTS

Number of plants of all species ranged from 1 to 33 per square foot for the 2 years studied. In 1957 the average density for all treatments was 9.4 plants per square foot; the next year the count was 10.7 plants per square foot if the 21 grazed plots are excluded, or 8.5 plants if the plots are included. The difference in count between years was not significant. The high count observed in the third growing season indicates that the reseeding trial as a whole was successful in establishing an adequate stand of grass under the current climatic conditions. The reseeding study was conducted during a wet climatic period when growing-season moisture was probably quite favorable for grass establishment, regardless of treatment. Thus, the conclusions from this experiment might be different in years of drought.

This performance fell below that reported by Bethlahmy (1) for the Cascade Range of Oregon. There, on logging roads, where precipitation measures 110 inches per year, an average count of 31 plants per square foot was observed. In northeastern Washington, from adaptation tests of 18 forage species broadcast seeded, Evanko (3) found that counts ranged from 0.2 to 22 plants per square foot. His tests were not carried out on logging roads, however, but in ashes of a freshly burned lodgepole pine stand on a shallow, well-drained soil derived from granite.

Table 1 gives the average number of plants per square foot and percent of ground cover for 1957 and 1958 data by scarification treatment, with and without wood-chip mulch. This table shows, for example, the generally higher number of plants on northeast aspect plots and on unmulched plots; and the slight superiority of the scarify-and-seed treatment over the other three. Two plots representative of low and high average number of plants per square foot are shown in figures 1 and 2.

Table 1. Average plant density and percent general cover according to treatment and aspect, Little Owl logging road

Scarification and other treatments[1]	Southwest aspect				Northeast aspect			
	Plants per sq.ft.		Percent ground cover		Plants per sq.ft.		Percent ground cover	
	1957	1958	1957	1958	1957	1958	1957	1958
Seed (control):								
Without wood-chip mulch	10.3	6.9	7.0	7.3	11.1	8.6	13.0	5.8
With mulch	6.7	6.9	5.9	5.2	12.8	12.5	7.1	5.4
Seed, harrow:								
Without mulch	10.7	10.1	7.6	6.1	11.6	9.4	8.5	6.2
With mulch	5.1	5.6	1.5	5.2	7.1	6.8	4.1	2.4
Seed, scarify:								
Without mulch	6.5	6.2	5.2	6.2	11.0	9.0	19.8	5.5
With mulch	5.9	7.2	5.5	5.7	7.4	8.1	3.8	3.5
Scarify, seed:								
Without mulch	10.9	13.5	8.0	7.5	14.4	11.3	16.9	4.6
With mulch	8.0	8.0	2.8	5.9	10.4	8.6	4.4	3.3

[1]Figures for treatments combine results for the treatment alone and the treatment plus fertilizer.

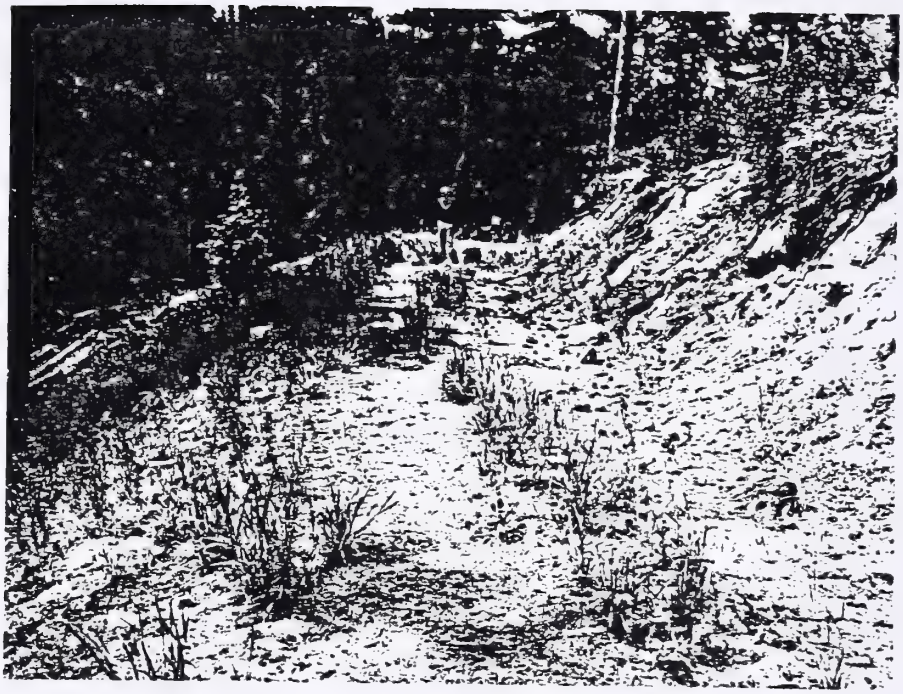

Figure 1.--Effect of wheel compaction on roadbed plot 27. This plot has an average of six plants per square foot.

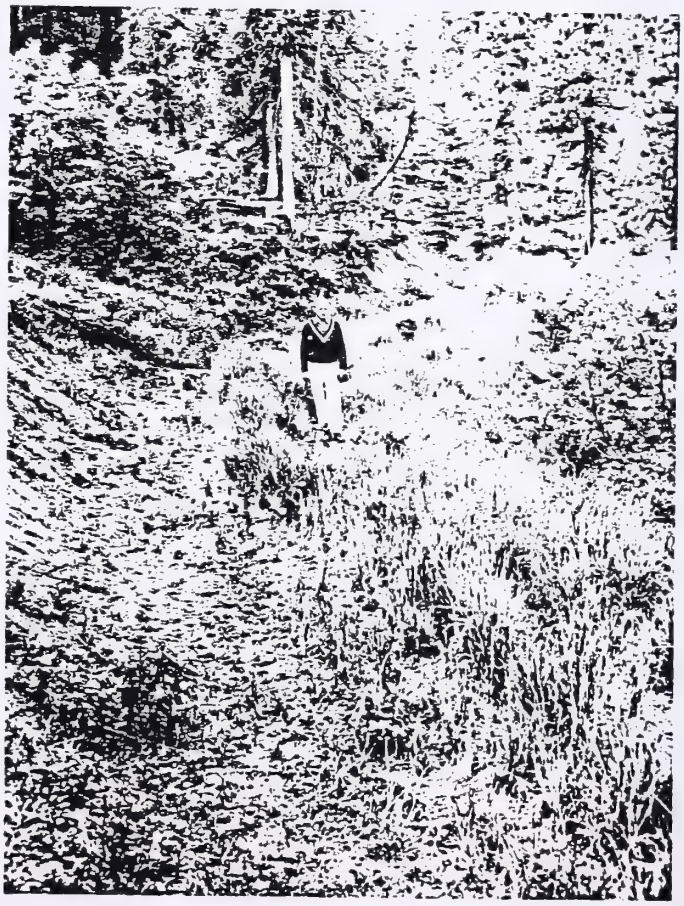

Figure 2.--Roadbed plot 76, north facing and nearly level, with an excellent stand of grass averaging 24 plants per square foot.

SCARIFICATION

Comparison tests between scarification treatments and controls revealed the results given in table 2. As indicated, the deep scarification treatments varied significantly from the control both in 1957 and 1958. Seeding of grass prior to deep scarification proved less effective than seeding alone, probably because the ripping action covered some seed too deeply. On the other hand, seeding of grass immediately following deep scarification proved to be a slightly better method of increasing plant density. Postseeding may have had two advantages: (a) it allowed loosened soil material to slough and cover seed, and (b) it permitted surface water and seedling roots to penetrate easier.

MULCH AND FERTILIZER

Results of additional treatments are shown in table 3. Mulching with wood chips had a depressing effect on plant density. When fertilizer was added with the wood chips, the decrease in plant count was less than with wood chips alone, although the difference was not significant. The use of fertilizer alone appeared to be related to an improvement in plant density although, again the difference was not significant in either year of study. Klomp (7), in reseeding scablands in Oregon and Washington, included treatments using 1/2- and 1-inch layers of wood chips, disked in and not disked, with nitrogen fertilizer and without. He found that chips plus nitrogen fertilizer (300 lbs. N per acre per inch of chips) yielded best results. This is contrary to our findings, where plots treated with a mixture of wood chips and fertilizer yielded fewer plants per square foot (although not significantly so) than untreated plots. This discrepancy may exist because in our study a much smaller amount of nitrogen fertilizer was applied per acre. It is also entirely possible that available nutrients from the small amount of fertilizer used had leached out of the soil by the second growing season, resulting in a lack of significant difference in growth between fertilized and control plots.

Table 2. Effects of scarification treatments

Treatment	Plants per sq.ft.		Percent ground cover	
	1957	1958	1957	1958
Broadcast seed (control)	9.4	10.7	8.2	12.5
Seed, harrow	9.3	12.2	5.4	13.6
Seed, deep scarify	5.4**	7.1**	8.6	11.9
Deep scarify, seed	13.4*	12.5*	8.0	11.2

* Comparison with control significant at 7-percent level.
** Comparison with control significant at 5-percent level.

Table 3. Effects of wood-chip mulch and fertilizer

Treatment	Plants per sq.ft.		Percent ground cover	
	1957	1958	1957	1958
Control	9.4	10.7	11.5	16.3
Wood-chip mulch	5.8*	12.2	3.0*	9.6*
Fertilizer	10.6	8.9	10.0	12.1
Mulch and fertilizer	7.4	9.4	5.6*	11.6

*Comparison with control significant at 1-percent level.

EFFECT OF SITE VARIABLES

Several site properties affected plant density in the 2 years of measurement. Plant density was related positively to aspect. The density of plants per square foot increased as the roadbed aspect changed from south to north.

The amount of shade cast by surrounding trees and topography was related beneficially to plant density, but not significantly so.

Roadbed compaction caused by posttreatment vehicular trips back and forth over the roadbed had latent adverse effect on plant density (see fig. 1).

SPECIES PERFORMANCE

Results in terms of seedling establishment for the six species are shown in table 4. Manchar smooth bromegrass and the two wheatgrasses--intermediate and standard crested--produced the greatest number of plants per square foot, almost 71 percent of the total plant count. Their establishment percentages, based upon number of viable seeds broadcast per square foot, were also the highest, 16 to 22 percent, indicating that of the five perennials tested, these three grasses appeared to be best adapted to the growing conditions of the study area. Interestingly, in 1957 smooth bromegrass and winter rye were more abundant on the cool, northeast aspects than on the southwest aspect. The southwest aspect was superior for bulbous bluegrass. By 1958, winter rye had practically disappeared from the roadbeds.

Other adaptability studies conducted in the ponderosa pine zone of the Intermountain and Rocky Mountain regions show Manchar smooth bromegrass and the two wheatgrasses as being well suited. Evanko (2), working in a large ponderosa pine opening in northeastern Washington, rated the wheatgrasses in a superior group and Manchar smooth bromegrass in the next-best group. He found timothy unsatisfactory in all respects, but rated orchardgrass as good as the wheatgrasses. Johnson and Hull (6) reported that intermediate and crested wheatgrass, smooth and meadow bromegrass, Russian wildrye, and big bluegrass out of 82 species tested appeared to be the most vigorous and generally adapted to central Colorado.

Table 4. Seedling establishment data for six grass species

Species	Maximum possible germination[1]	Mean seedling establishment		Seedling establishment			
				1957		1958	
		1957	1958	South-west	North-east	South-west	North-east
	--Seeds/sq.ft.--	--Plants/sq.ft.--		----------Percent----------			
Wheatgrasses Crested) Intermediate)	[2]23.0	3.7	3.9	15.8	16.0	17.8	16.3
Manchar smooth bromegrass	14.8	2.9	2.3	15.8*	22.0	16.8	14.8
Timothy	24.0	1.7	1.3	8.4	6.3	5.0	5.4
Bulbous bluegrass	18.6	0.6	0.8	3.9*	1.8	5.8	3.4
Winter rye	7.9	0.5	0.2	4.7*	6.7	2.0	1.8
Total[3]		9.4	[4]8.5				

[1] $\frac{\text{Seeds per lb. X germination percent X lb. per acre broadcast}}{43560}$

[2] Seedlings of these two species could not be differentiated accurately.

[3] Difference between totals by years not significant.

[4] If 21 grazed plots are excluded, total = 10.7. Footnote 3 applies.

* Difference between aspects significant at 5-percent level.

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Deep and shallow scarification treatments, before and after broadcasting seed, were studied to determine if they would be conducive to establishment of a heavier stand of grass than could be obtained by merely broadcasting seed. Mulching with wood chips and fertilizing were also tried. Results show a slight advantage for deep scarification before seeding. Three of five perennial species became well established; the other two did poorly. Crested and intermediate wheatgrass and smooth brome produced good cover; timothy and bulbous bluegrass produced sparse cover. Establishment of seedlings was significantly affected by site aspect and mulch.

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Headquarters for the Intermountain Forest and Range Experiment Station are in Ogden, Utah. Project headquarters are also at:

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